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Department of Agriculture, Bombay.

REPORT

UPON THE

ENTOMOLOGICAL WORK

CONDUCTED IN THE

DISTRICT

DURING THE YEAR

1907-1908

BY

T. FORSTER MAIN, B.Sc.,
Deputy Director of Agriculture, Bombay Presidency.

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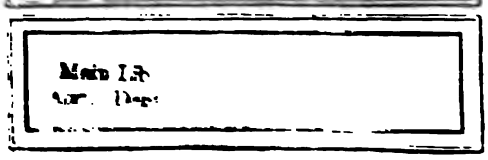

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ENTOMOLOGICAL REPORT.

1. The Entomological work conducted by my branch of the Department has been under the charge of Mr. Ramrao S. Kasarode, Assistant Entomologist to the Deputy Director of Agriculture.

The work has been conducted for the most part upon the Experimental Farms under my charge, but Mr. Ramrao has also toured extensively and moved among the cultivators of various districts.

2. In his work Mr. Ramrao has concentrated the major part of his attention upon practical remedial and preventive measures and has confined purely systematic work to the minimum compatible with his duties as a whole. It will be seen that the work of the Assistant Entomologist has been entirely of a "destructive" nature in the year under report, but it is hoped in the coming season to initiate investigations into the "constructive" side of this science. I refer to the possibilities of sericulture which exist in this Presidency. There is in the first place the indigenous silk worm —Bombyx fortunatus—which thrives over the whole Presidency. In the second place both the mulberry and castor—the natural food plants of silk worms—thrive throughout Bombay. There are already 2 or 3 small sericultural farms established in Western India. There is one in the Baroda State and one at Belgaum. I have not had an opportunity of visiting the farm in the Baroda State, but I had reason to inspect the Belgaum Sericultural Farm a little while ago, and was glad to find that the enterprize showed every promise of success. On further enquiry in the Southern Maratha Country it has come to my knowledge that sericulture was at one time a village industry in the Dhárwár Collectorate and there are still signs of its remains by the mulberry bushes which have survived and which may be seen in numerous gardens. Report says that the cause for the disappearance of this industry was that the original people who introduced the industry either left the neighbourhood or died out. There is the additional question of demand; this already exists in the neighbourhood of Belgaum in the Shábpur Táluka of the Sángli State where raw silk is annually imported to the value of 4 or 5 lacs of rupees and supplies material for 6,400 reels and 609 workers.

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3. Thus it will be seen that there is every reason Government should take active measures to investigate possibilities of the silk industry in this Presidency and especially in the Southern Marátha Country around Belgaum

4. To return however to the work of the past year whicl been accomplished I propose to report in some detail the taken, and the success obtained, in dealing with the more im ant insect pests of the Presidency and finally I shall repor progress made with the more systematic side of the work conn with this science.

The Potato Moth.

5. Probably the most successful work of the year has been .t done in connection with the potato moth. It may not be out of ce here to briefly summarize our knowledge regarding this insect ;ained up to the present time. The pest was first brought the notice of this Department in 1906 through the instru- ntality of a potato cultivator of Belgaum and its importance s worked out when investigating a large number of complaints)ught to the notice of officers of this Department by neighbour- ; cultivators. It was soon seen that the moth ranked in portance with such injurious insects as the granary weavil or) bean bruchid.

Specimens were forwarded to the Imperial Entomologist ıo replied as follows :—

"I am afraid there is little doubt that the Dhárwár potato)th is the well-known *Lita Solanella* common in Europe and ıstralia. If so, this adds one to the list of introduced insects in dia."

Subsequent investigations have confirmed the above remarks d it seems to be only a question of time until this insect has ;ablished itself all over India and turned its attention to plants ıer than the potato; there are a large number of cultivated)ps in India closely allied to the potato which are extensively)wn; these include such common crops as tobacco, tomatoes, illies, brinjals and others, besides a large number of wild anaceous plants commonly found as weeds in cultivated fields.

The approximate damage caused from the ravages of this ıect has been put at 18 to 20 per cent.

6. The following is a description of the insect prepared my Assistant Entomologist, which may be accepted as correct all points of practical importance :—

Bibliography Lita Solanella Oliff also Phthorimæa Operculella Lell.

The Moth.

Moth is greyish brown, with ochreous tints intervened, sterior wings lighter but similar in colour to anterior wings.)th the anterior and posterior wings are well fringed, the posterior nger fringed than the anterior. Palpi prominent. The wings lded in a somewhat roof-shaped manner over the abdomen.

The length is 8 mm. and wings expanded it measures 16 r
from tip to tip. The moth is characterized by its rapid fli
Female rather more robust and larger than male.

The eggs and oviposition.

The egg is $\frac{1}{4}$ mm. in diameter and $\frac{1}{3}$ mm. long; oval-sha
with a pearly lustre under magnification. The eggs are laid
most inconspicuous places and difficult to detect. The fem
always seeks the eye of the potato lay her eggs. The eggs
attached by means of a gummy substance which soon hardens.
big cage where the pest was being bred disclosed potatoes v
eggs only in the eyes. One moth laid 25 and the other 29 e
The moth does not lay more than two or three in each eye.

The larva.

The larva is 1 mm. long when just hatched. The head
thorax is of a dark colour and the abdomen is of transparent wh
Moths could not be determined as the larva is of a burrow
habit. The mature larva shows different colours. Light p
and blue with dirty white here and there are to be found, but
constant on the same parts of different caterpillars and
difference is inexplicable unless it be ascribed to the caterpil
feeding on the surface or deep in the centre of the potato.
maximum length of the caterpillar before pupation is 10 mm.

The pupa and pupation.

Pupa 6 mm. long, at first light yellow and then it turn
a rich brown until the moth emerges. Abdomen movable
segments well defined. Ventrally placed antennæ are v
prominent. Spiracles 8 in number can be marked easily un
magnification. Eyes are prominent. The female pupa is a li
bit bigger than that of the male.

The pupation of the insect is interesting and can be obser
satisfactorily when about 6 weeks old; it then comes to the sur
and either pupates in the mouth of its burrow after it has bro
through the epidermis or seeks some depression on
potato or may find its way into some crack or cranny of
receptacle in which the potatoes have been stored. It has b
frequently observed during this investigation to find its way
the folds of the sacking in which the potatoes were k
Generally speaking the worm finds a more or less secluded pl
and there pupates. The satisfactory spot having been chose

oceeds to spin its cocoon therein. A carpet piece of silk is well stened to the surface, the cover piece being woven at the same ne, the two together forming a sort of pocket smooth and white . the inner side but on the outer side with bits of trash, generally e thin skin that peels off the potatoes. The finished cocoon is appearance a piece of dirt and nothing more. When the cover- g is arranged satisfactorily the worm gets beneath it and sews gether the opening remaining at the end of the pocket and trans- rms to the chrysalis in safety within it. It was once noticed ring the field investigation that a countless number of worms d pupated on the sacking on which a cultivator had spread his tatoes.

Life History.

7. A series of observations covering the life of the insect for arly a year were taken. Two lots of moths were studied con- rrently, and the results seemed to agree in the main points. lot of moths were let loose in a wire gauze case with a small antity of good and sound potatoes. One pair which was copu- ting was removed to another similar cage. Eggs were laid the 4th March and 25 were counted on the 8th when the oths were dead.

A similar second cage showed 29 eggs. On the 10th some tched from the first cage. Pupation was marked on the 8th April and on the 19th the moths began to emerge. Eggs took days to hatch, caterpillars took 23 days to mature and remained 2 days under pupation. Total for the generation 6 weeks 4 days. a second cage the eggs were laid on the 6th, hatched on the 8th, began to pupate on the 12th April and from the 24th began emerge. Eggs—7 days; larva—29 days; pupa—12 days; tcgether 6 weeks and 6 days.

From these observations one generation is completed in 6 to 7 eeks' time. This study of the life of the insect is significant om the fact that the conditions for living and propagating were ie same as are found when potatoes are stored and as such there ould not be any difference in the moths bred in the laboratory id those under natural conditions. The result indicates con- lusively that the injury is progressive in a store of potatoes and s the moth can breed the whole year round there could be 7 o 8 generations. A very small primary infection may in a few onths mean the destruction of the whole lot of potatoes. The ood beirg always present the post increases by leaps and bounds ist as in the case of the granary weavil.

Nature of the damage done by this insect.

8. The damage committed by this moth falls into two distin divisions. There is first of all the injury to the growing crop the field and secondly the damage to the stored produce in godowns.

It should be noted here that the moth effects its initi damage in the field whence it spreads to the stores. The inju in the field is insignificant when compared with the subsequ damage perpetrated in the godowns. In the fields dam sustained by the potato crop may be summarised as follows :—

Plants have not been observed to suffer much owing to presence of the caterpillars of this moth preying upon the when the moth deposits her eggs upon the potato plant she see some desirable spot such as the base of a leaf in which to pla her eggs ; the young larva on hatching feeds upon the epiderm of the leaf until it has gained sufficient strength to burrow bel the surface ; it then finds its way under the midrib of the lea the channels under the leaf made by the larva can soon be se because the portion to the rear of the larva becomes filled wi excrement of a darkish colour which gives a different shade colour to that portion of the leaf which is attacked ; this differen in shade can be easily seen by the observer. The larva then a parently continues its course in a downward direction along t stem but does not proceed far before opening an exit throu which it comes out. The caterpillar next finds its way dow to the soil and if potatoes are found will effect an entran Mr. Ramrao, who has made a large number of careful observatio has in no instance found the caterpillar proceeding the whole w down the inside of the stem to the tubers. If this observation not subsequently proved to be an inaccurate one, it is of highest value because a most effective preventive measure at on suggests itself in earthing up and preventing any tubers from beco ing exposed owing to surface washing or other causes ; such tube generally assume a green colour and it has invariably been notic that these potatoes are infested with the grubs of this moth.

9. The second source of damage to which potatoes are liab from this moth is unquestionably a much more serious aff Here it is necessary to diverge for a brief space to describe system of storage adopted at Belgaum and other places in Bombay Presidency. It is almost the universal practice to thro the tubers into a heap in a shed or room and to put no protecti covering over the heap. The pest experiences little difficulty breeding freely in the loose heap of potatoes. The moth advise

ects the eye-buds so that the delicate larva may experience
le difficulty in effecting an entrance into the tuber; the cater-
lar soon burrows into the tissues of the potato leaving in its
ke at the eye-bud, or place of entrance, a small quantity of
crement which at once attracts the notice of the careful observer;
caterpillar appears to be indifferent as to which direction it
uld take after gaining access into the tissues of the tuber; it
y burrow along and keep close to the epidermis or it may strike
right into the middle of the potato; when the burrow is
epidermal it may be easily seen from without owing to the
inkage of the tissues on either side of it while the channel itself
omes packed with excrement. Moulds soon find an entrance
ough the channels tunnelled out by this caterpillar with the con-
uent decay of the surrounding tissues which together with the
crement of the insect renders the tubers quite unfit for human
sumption. The potatoes are, therefore, unsaleable and the
ner may suffer a depreciation in the value of his produce to the
ent of 75 per cent. depending upon the prevalence of the
tato moth.

10. With regard to the general practice of the cultivators
respect to harvesting and storage the following points should
noted:—

(1) In raising the potatoes it is the custom to remove the
ulms and put them in a heap in the corner of the field; the
bers are then dug out and these may be left exposed in a heap
ernight until the cultivator finds it convenient in the morning
remove them to his godown. This is a most favourable op-
rtunity for the potato moth to lay her eggs upon the exposed
bers; the moth when kept under artificial conditions in the
oratory has been observed to take full advantage of such a
vourable opportunity. The cultivator then removes his produce
the godowns and throws them into loose heaps without separat-
g the green or immature tubers from the sound and mature
es. At this time unless the potatoes were examined critically
e pest would not be noticed. After about a couple of months
a little longer the moth manifests itself. Owing to the loose
ndition in which the tubers are heaped the conditions for pro-
gation are most favourable and the insect rapidly multiplies.
ie cultivators are in the habit of turning over the potato heaps
ery 15 or 20 days and separating those which they observe to
attacked; these diseased tubers are collected into a corner of
e same room until there is a favourable occasion for selling the
me in the bazar. Under these circumstances there can be little
ubt that the infection is very largely due to the presence of the

green tubers which harbour the grubs at the time of harvesti the crop.

Thus the primary source of damage seems to be in the esca of the moths from the godowns or from the refuse potatoes left the field (partly cut and decaying tubers are left to rot in t fields at the time of harvest). No other plants in the pota growing locality around Belgaum have been observed to attr this pest although there are a large number of plants (both cu vated and wild) belonging to the same natural order of solanac These plants have been carefully examined after the potato sea was over but without any evidence that they were subject to attacks of this insect.

11. Preliminary to recommending any preventive or reme measures it may be of some interest to report the experime which have been conducted in the laboratory and field in conn tion with this pest.

(1) An experiment was conducted to ascertain the effec planting seed known to be infested with the grubs and pupæ this moth.

For the purposes of this experiment a number of field ca with wire gauze sufficiently small in mesh to prevent the pass of the potato moth were prepared. The result of the experim was that no moths were observed to emerge from the soil wl the plants bore a healthy appearance and gave a normal yield. would thus seem impossible for the tiny moth which emerges fr the pupæ contained in the seed sown, to force a passage up thro the soil. This fact should not be confused with the ability wh the caterpillar has of passing underground from one tuber another as was demonstrated by the following experiment.

(2) This experiment was designed with the object of ascerta ing whether the caterpillar of the potato moth could pass thro the soil either from a tuber above the surface or from one tu to another both below the surface. Good healthy potatoes w sown in a flower-pot in a cage and infested ones were placed the surface above. After the lapse of a month the potatoes in soil were found to contain pupæ of the moth. Simultaneo within a separate cage sound tubers were sown in pots. tubers remained sound and bore a healthy crop. This seem indicate that infection is due to causes other than the sowing seed infested with the grubs of this insect.

(3) An experiment to test whether the green exposed tub actually do act as a source of disease in the stores. For purpose a small number of green tubers were put in a bag c taining sound tubers. After about a month it was obser

ıat the whole contents of the bag had become infested with rubs, the tubers being riddled through and through with the aterpillars and reduced to a condition of decay. At the same me sound tubers were put into another bag and the two bags ıroughout the experiment were placed in close proximity to one nother.

The contents of the bags filled only with sound tubers ɔmained intact except for a few tubers which became rotten; o tubers however were found to contain the grubs of this moth. he result of this experiment naturally suggested the storage f potatoes in bags and this was carried out upon the Dhárwár arm with excellent results. The caterpillars appear to be dis-ıclined to travel from one bag to another.

(4) The remaining experiment was designed to test the effect f carbon bisulphide upon this insect.

For this purpose a large number of potatoes were selected ıd divided into three groups—

(*a*) Potatoes infested with pupæ.

(*b*) Potatoes infested with larvæ.

(*c*) Potatoes covered with eggs.

These were fumigated by placing a portion of each in a ɔecially designed box of 15 cubic feet; the carbon bisulphide ɔed for fumigating the space was 1 oz. and the box was left osed for 10 hours. The results were very satisfactory. In the ıse of the potatoes infested with pupæ it was found that all the upæ had succumbed to the effects of the fumes given off from ırbon bisulphide.

In the case of the tubers infested with caterpillars; these, ter fumigation, were placed within a cage of wire gauze and ft for observation. No moths, however, emerged—the cater-llars had in fact all succumbed. In the case of the tubers bearing ggs it was found that all the eggs subsequently hatched out and ıis in spite of the fact that the strength of the carbon bisulphide as made double. It would seem from the above experiment that ıe fumes of this gas have no influence upon the germ of the insect ıt are fatal to the insect during other stages of its life. More-ver, the effects of these fumes have no deleterious influence upon .e germination of the potato seed.

12. In view of the knowledge which we possess of the habits ıd life history of this insect and also in the light of the experiments ıscribed above, it is possible to make certain suggestions, for the ntrol of this insect, with considerable confidence.

(1) Sound seed should be sown because although tl disease does not appear to be propagated through the use unsound seed, still the germinating power, owing to the habit the caterpillars effecting its entrance into the tuber through tl "eyes," is adversely affected and moreover we have seen that tl caterpillars can pass through the soil from infested seed and ent tubers which, when sown, were sound.

(2) Every care should be taken to earth up the potat ridges especially after heavy rains which owing to their scourin action may have left tubers in an exposed condition. The result of an experiment carefully conducted upon the Dhárwár Far indicate the success of this treatment as will be seen from reference to the table below:—

No. of plot.	Treatment.		Yield in lbs.			Total weight in lbs.	Number of potatoes attacked by the worm.	Remark
	Manurial.	Cultural.	Sound.	Worm injured.	Rotten.			
			Lbs. ozs.	Lbs. ozs.	Lbs. ozs.	Lbs. ozs.		
83a	Farmyard manure.	Earthed up ...	40 8	*Nil*	2 4	62 8	*Nil.*	
83a	Do. ...	Unearthed ...	35 8	1 14	4 2	48 0	29	
83b	Farmyard manure + superphosphate.	Earthed up ...	43 8	*Nil*	2 8	57 0	*Nil.*	
83b	Do. ...	Unearthed ...	54 0	1 6	6 10	72 0	14	
83c	Farmyard manure $+Na\,N\,O_3 + K_2\,S\,O_4$.	Earthed up ...	41 4	*Nil*	2 4	61 0	*Nil.*	
83c	Do ...	Unearthed ...	53 6	1 4	4 0	73 0	16	
83d	Farmyard manure $+ K_2\,S\,O_4$.	Earthed up ...	23 12	*Nil*	1 12	38 0	*Nil.*	
83d	Do ...	Unearthed ...	22 0	1 2	2 8	39 10	19	

Note.—The exceptionally good results obtained must be ascribed partly to the care of Mr. M. L. Kulkarn Superintendent, Dhárwár Experimental Station, where the experiment was conducted.

(3) All parts of the plant whether haulms or diseased tubers should be destroyed or removed from the potato field a the time of harvesting the crop because these harbour the grubs o the potato moth.

(4) Potatoes should never be stored in open heaps i godowns but should invariably be covered over with sacking o kept in closely woven gunny bags.

(5) Green or immature tubers and all which show signs o disease should be drastically excluded from the store.

(6) The potatoes in the store should be turned over a intervals and all infested or diseased tubers removed; the bag themselves should be carefully examined because the caterpillar are likely to cling on to their surfaces.

(7) When there are facilities for fumigation this treatment should always be adopted at the time of harvest and before the tubers are put away in the godowns. To make this treatment quite successful, however, it will be necessary to repeat it a second time at an interval of not less than one month, precautions being taken in the meantime to exclude all possibility of an entrance by the moth being effected. The necessity for the second fumigation is due to the fact that the first treatment does not in any way injure the eggs and the second is necessary to destroy the caterpillars which hatch out from these eggs. Fumigation by means of carbon bisulphide is not a very practical remedy owing to external causes; the chief of these is the difficulty of obtaining this substance. It is only procurable in Poona or Bombay and the Railway authorities object to its transport owing to its dangerously inflammable nature. Moreover, the cultivators have no suitably constructed boxes or rooms which are quite air-tight and hence they could not carry out the work themselves. It would not however be at all an insurmountable difficulty for this Department to open a small fumigating Depôt at Belgaum and fumigate all tubers brought in by cultivators. This would be a real boon to cultivators who cannot preserve seed for the following season owing to the ravages wrought in the stores by this insect and who therefore have to import fresh Italian seed annually.

(8) Spraying experiments with lead arseniate can be recommended to kill the caterpillars of the early brood that may be found feeding upon the epidermis of the leaves of the potato plants.

Prevention of the spread of the Potato Moth.

13. It is more than probable that this widely distributed potato pest over the continents of Europe, America, Australia and Asia was originally introduced into India through the importation of seed from Europe. This pest has been known to the cultivators of the Belgaum District for only some 6 or 7 years, but it seems to have been introduced earlier mainly for the reason that it is now found all over this Presidency in such far-apart places as Ahmedabad in the North, Khed and Junnar Tálukas in the centre and Belgaum and Dhárwár in the South; with the extension of the irrigational facilities which are likely to continue and increase rapidly in the next few years, it is likely to spread still further afield and it seems to be the duty of Government to take the necessary measures to prevent such a catastrophe. It is understood that the Government of India have under consideration a scheme for

the control of all imported seed or plants with a view to excluding from this Empire the introduction of other equally dangerous pests and diseases.

At the present time the potato crop grown in the Dhárwár Collectorate depends entirely for seed upon the crop produced around Belgaum and when Belgaum has a bad season from this or other causes the area put under potatoes in Dhárwár proportionately contracts.

White Ants.

14. There are three species, if not more, of white ants found in the Bombay Presidency, of which one—Termes Obesus—is the common field white ant which annually causes so much damage to the crops of this Presidency.

It is found that these insects effect their maximum damage in the light sandy soils of the Kaira and Panch Mahâls Districts of Gujarât and practically render the cultivation of such otherwise valuable crops as sugarcane and groundnuts outside the range of practical agriculture.

15. In 1907 upon the Nadiâd Experimental Station an experiment was conducted to test the effects of castor-cake and kerosine oil as preventives of these insects. The crop selected for the trial was groundnut. The results of the experiment showed that kerosine was the more efficaceous of the two, but on account of the additional value of castor-cake owing to its manurial properties the yields upon the two plots were the same.

16. An effort was again made in 1908 to find some efficaceous treatment and the following experiment was accordingly laid out.

The following 16 treatments were tried :—

1. Jambo cake at the rate 600 lbs. per acre.
2. Castor cake do.
3. Neem cake do.
4. Neem leaves to be spread to a depth of 1½ inches on the surface and then incorporated in the soil.
5. Mowra cake at the rate of 600 lbs. per acre.
6. Karanji cake do.
7. Farmyard manure.
8. Ammonium sulphate at the rate of 150 lbs. per acre.
9. Basic slag at the rate of 300 lbs. per acre.
10. Lime at the rate of one ton per acre.
11. Asafœtida and salt
12. Crude oil emulsion
13. Soft soap
14. Kerosine oil

(11–14: These will be applied in the irrigation water each time the plots are watered.)

15. Burning the soil before planting by means of a mulch of leaves and straw.
16. No treatment.

The land was uniformly manured with 15 tons of farm yard manure. All operations other than those mentioned were uniform for all plots. In the case of plots 1, 2, 3, 5 and 6 the manures were applied ½ before planting, ¼ at the time of ridging and ¼ in the irrigation water.

The neem leaves in the case of Plot No. 4 and the farm ya manure in the case of Plot No. 7 were applied before the cane w planted.

The ammonium sulphate in the case of Plot No. 8 and t basic slag in the case of Plot 9 were applied ½ before sowing an ½ at the time of ridging.

The crop in the year under report was sugarcane which w sown on the 13th May and when the crop was inspected o the 29th June it was found that the percentage number of plant attacked and killed by white ants was as under:—

Treatment.	Percentage numbe of plants killed.
No manure	45·44
Rabbing	47·44
Neem leaf	40·56
Lime	48·80
Castor cake	49·84
Jambo cake	56·32
Karanji cake	60·16
Mowra cake	51·20
Neem cake	54·52
Farm yard manure without anything else (control plot)	52·80
Ammonium sulphate	58·00
Basic slag	57·26
Asafœtida and salt	49·04
Crude oil emulsion	53·36
Soft soap	65·20
Kerosine	78·32

It will be seen that the mortality has been very excessive, bu white ants unfortunately were not the only pest which attacke the plants. Borer proved to be extremely bad and owing to th age of the plants when the examination took place it was no possible to accurately determine the relative amount of damag caused by each of these pests respectively, but a fair computatio indicates that at least half the damage should be ascribed to th borer moreover the fact should be recalled that white ants ar particularly severe upon unhealthy or injured plants and it i more than probable that their attacks in many of the cases wer secondary to the borer which directly and indirectly has been th cause of the major proportion of the damage.

It will be observed that the neem leaf plot has so suffered to the least extent while the plots treated with kero oil, soft soap, crude oil emulsion and asafœtida have given v bad results and the quantity of these substances has now b increased twofold. The total quantity applied up to date (3 June 1908) has cost from Rs. 9 to Rs. 10 per acre and hence quantity will not be further increased because such treatm would be beyond the reach of the ordinary cultivator owing to expense.

The experiment, which is by no means complete yet, will continued and the injury due to borer will be eliminated and t caused by white ants accurately recorded.

17. There is a common belief that winged white ants st new colonies and a trap was accordingly arranged by hanging u couple of lights every night at the Nadiád Experimental Stati A very large number were thus killed, but there is no very defi way by which the effect can be measured.

The above statement shows the number of winged wl ants destroyed in this way. It will be seen that on rainy d the vast majority were killed and it seems to be a us precautionary action to hang up lamps during wet weather.

Sugarcane Borer—*Chilo simplex.*

18. The sugarcane borer or Chilo simplex has been the subject of constant attention throughout the year. This is one of the most troublesome insects in India and it attacks a number of the staple crops, such as sugarcane, jowári and maize.

In 1906 advantage was taken of the fact that this insect attacks maize by employing maize as a trap crop which was recommended by the Imperial Entomologist. The trial was conducted at Nadiád but accurate results were not obtained because the sugarcane was damaged by white ants and the crop had to be grubbed up. It was, however, found that the borer preferred the maize to the sugarcane and that the maize could be safely used if precautions were taken to destroy the plants when they became attacked; if left the maize of course would only act as a breeding ground and additional source from which the borer would spread.

19. Sugarcane is generally attacked by this insect in its early stages and those plants which survive the attack throw up two weakly shoots in the place of the proper single but stout shoot; it is therefore better on the whole to resow the crop when there is a bad outbreak of borer. The crop therefore requires protection for the first three months of its existence and if any suitable protection could be devised the cultivator would indeed benefit.

With this view an enquiry was initiated to ascertain at what time of the year this moth is scarcest. For this purpose attempts were made to rear specimens from jowár stubbles at different times of the year. It was found that those caterpillars which were collected in November metamorphosed into moths within a few days which however proved to be "Nonagria" and not "Chilo." The rest of the caterpillars remained in the larvæ stage and hibernated. By the end of February only two moths of Chilo simplex emerged and the remainder emerged between the 15th March and the beginning of April. It would thus appear that the Chilo simplex undergoes a long period of hibernation throughout the cold weather. When there happens to be irrigated jowár or maize this period may be a little shorter.

20. This trait in the character of the insect may be taken advantage of, for the cane planted in November and December will enjoy a period of three or four months when there are practically no Chilo simplex moths upon the wing. Even if the cane were attacked at a later date it would not suffer to the same extent.

21. The following statement has been drawn up to compa the dates of sowing sugarcane in the Presidency with the prevalen and extent of damage wrought by this insect. For want trained men it has not been possible to collect data for the secor part of the table, but an effort will be made in this direction ne year and meanwhile attention may be drawn to the fact that tl usual dates for sowing cane even in different parts of the san district vary very considerably :—

	Name of the District.	Dates from sowing in the Districts.	
		From	To
1.	Ahmedabad	15th April ...	5th May.
2.	Kaira	15th May ...	25th May.
3.	Panch Mahâls	Kharif—10th April ...	25th April.
		Rabi—25th January...	1st February.
4.	Broach	.....	.....
5.	Surat	5th November ...	30th Novembe
6.	Khándesh	15th February ...	10th March.
7.	Násik	15th January ...	28th Februar
8.	Poona	1st February ...	31st March.
9.	Ahmednagar	Kharif—20th January	31st January.
		Rabi—31st March ...	10th April.
10.	Sholápur	15th December ...	30th April.
11.	Sátára	Kharif—1st February .	31st March.
		Rabi—1st December .	1st February.
12.	Belgaum comprising parts of Athni, Gokák and Parasgad Tálukas.	10th March ...	1st May.
	Belgaum comprising Chikodi, Gokák and Parasgad.	1st December ...	25th April.
	Belgaum comprising Belgaum, Khánápur and part of Chikodi.	15th January ...	15th Februar
13.	Bijápur	15th March ...	15th April.
14.	Dhárwár, Malád hilly or western portion.	1st February ...	1st March.
	Dhárwár District plain or eastern portion.	23rd January ...	10th Februar
15.	Thána	Kharif—10th March .	30th April.
		Rabi—15th December.	25th Decembe
16.	Kolába	.....	.....
17.	Ratnágirí	15th December ...	15th January.

Name of the District.	Dates from sowing in the Districts.	
	From	To
18. **Kánara** comprising western portion of Kárwár, Ankola, Kumpta and Honávar.	5th January ...	15th January.
Eastern portion of Kárwár, Ankola, Kumpta and Honávar and western portions of Sirsi, Siddápur, Yellápur and Supa Petha.	15th March ...	20th April.
Eastern portion of Sirsi ...	1st January ...	1st February.
Siddápur and Supa, Haliyál and Mundgod.	Do. ..	30th January.

22. Should further investigations show that the laboratory observations described above are confirmed in the field early sowing of sugarcane in November or December can be confidently advocated and recommended and actual demonstrations conducted in fields in all the more important sugarcane centres.

Boll-worm.

23. This is a pest which is always with us but happily it neve ravages the deshi cotton crop in the Presidency to the disastrou extent to which it attacks the exotic crop of Egyptian cotton i Sind.

On the advice of Mr. Lefroy for the last two years attempt have been carried out on Government farms with Bhindi trap crop to see whether these were of material advantage in preventing serious damage from this insect. Bhindi, the common vegetable is closely allied botanically to cotton and this plant was selected t play the part of a trap in the year under report.

It is known that the boll-worm subsists upon bhindi after th cotton crop has been harvested and it has been observed tha the boll-worm shows some preference for bhindi over cotton whe the two are sown together.

24. Experiments were accordingly commenced two years ag on all farms to put to practical test the claims of the Imperia Entomologist for bhindi as a protection crop for cotton with regar to the boll-worm scurge. The results, however, were most unsatis factory because the bhindi plants did not grow well. The reason for this were :—

(*a*) Bhindi being a garden crop and accustomed t careful cultivation and to irrigation did not find a congeni environment when sown in a cotton field and treated simi larly to the cotton which receives very little attention aft sowing and moreover as the bhindi was sown around th cotton plots it did not share in the advantages of the inte cultivation given to the cotton crop.

(*b*) The shade from the surrounding crop checked th growth of bhindi plants.

(*c*) There appeared to be a deficiency of moisture for th bhindi crop which is naturally an irrigated crop.

25. The experiment in fact proved a failure at all the expe mental stations and it was reported by the Superintendents charge that wherever the seeds germinated and bore pods the were attacked to a greater or less extent. At Dhulia where th cotton season is a very short one; it was found that the bhin did not fruit till after the cotton was harvested. It therefo became obvious that if an experiment on these lines was to successful it would be necessary to find a variety of bhindi whi

would suit local conditions with regard to its time of coming to maturity.

26. In the year under report the experiment was conducted on the Surat and Dhárwár Experimental Stations.

At Surat the bhindi seed was sown in single lines one between every four of cotton while at Dhárwár the bhindi was sown round about the plots, and a weekly inspection was made in which all the bhindi plants and surrounding cotton plants were examined. At this time all the bhindi pods which were found to harbour the boll-worm were removed and destroyed. A special register was kept and the weekly figures carefully recorded therein.

The statement subjoined gives the general results of the experiment conducted at Dhárwár. It should be noted that the season was an unfavourable one and that both the cotton and bhindi sown at both stations were late ripening varieties and it was observed that before the plants flowered they were attacked by boll-worms in the stems which thus became a breeding centre for the boll-worm :—

Details of Experiments conducted with Bhindi as a trap crop for Boll-worm on the Dhárwár Experimental Station.

For the week ending	Cotton rows to the north of Bhindi row.			Row of Bhindi itself.	Cotton rows to the south of Bhindi row.		
	3rd.	2nd.	1st.		1st.	2nd.	3rd.
			Plot No. 36.				
4th January ...	...	...	...	20	...	...	...
11th do. ...	1	2	3	23	2	4	1
18th do. ...	1	1	...	27	...	2	2
25th do. ...	2	4	4	68	...	3	2
1st February ...	2	2	6	16	9	3	5
8th do. ...	5	10	20	31	10	3	11
15th do. ...	2	...	2	9	3	11	5
			Plot No. 37.				
4th January ...	...	...	...	8	4	3	...
11th do. ...	...	...	1	7	2	2	1
18th do. ...	...	1	...	4	...	...	1
25th do. ...	3	2	1	10	1	...	5
1st February ...	...	1	...	18	...	1	3
8th do. ..	3	4	2	34	3	1	7
15th do. ...	...	...	...	7	...	3	...

27. The general observations made throughout the experiment were (1) that the boll-worm was not plentiful in the year under report, (2) that the boll-worm showed a decided preference for bhindi, (3) that although the number of boll-worm in the bhindi rows was much greater than in the adjoining cotton rows still there were more cotton plants attacked in the rows, nearest the bhindi, than in the rows more remote from the bhindi row, which leads one to the conclusion that the bhindi also acted as a source from which the boll-worm spread to the cotton.

This last observation was also made at Surat and it was ultimately decided to uproot the whole of the bhindi and remove it.

28. The general conclusion to be drawn from this experiment up to date is that bhindi shows some promise of being a successful trap crop for boll-worm but it must be very judiciously handled.

The first point to be attended to is to find a variety which will grow well as a dry crop in ordinary cotton fields and which will come to maturity a short while in advance of the cotton. As soon as any bhindi pods are observed to be attacked these should be at once removed and destroyed and shortly before the cotton crop flowers the whole of the bhindi plants should be uprooted and removed. In this way the early brood of boll-worms could be destroyed before the cotton had reached the critical stage for being attacked.

29. In the coming season the bhindi used in this experiment will be an early ripening variety and its seed will be mixed with the cotton seed before sowing. It is possible that other plants of the Malvaceæ Order may prove better trap crops than bhindi. Such a crop is Ambadi (Hibiscus Cannabinus) which grows as a field crop without irrigation in the Dhárwár District.

Nonagria Uniformis.

30. The pest was first noticed in the rains of 1905 on jowár. he larva is a typical stem boring caterpillar with a tinge of pink er the body. The head is brown. It is over an inch in length hen full grown. In jowár it was found to pupate in the galleries made. Later on when jowár was harvested it continued to live i the stubble left after the jowár was harvested. The ratoon oots thrown up by the jowár stubble offer sufficient food for it live through the cold weather.

31. In 1907 the pest was again found on jowár but it did not crease sufficiently to cause damage. The pest was, however, und on rice and specimens of moths were reared from paddy ubbles. The pupea were found in the ground contrary to what as noticed in the case of jowár where it was found to pupate ly in the stems. The stems of rice being thin do not perhaps ow sufficient room for them to pupate inside. The presence of eat in the cold weather afforded sufficient food for the pest to e through the winter in the active condition to the detriment of eat which it destroyed completely. The early winter brood s destroyed by burying the plants that were first attacked. is seems to have had no effect on the wheat. After about a nth the whole crop was found to be attacked and yielded thing. It was found to be due to the rice stubble being left er after the rice was harvested. The rice stubble afforded a od breeding place and the moths as they emerged found sufficient d in the wheat crop. A pest of this sort which has two or ree alternative food plants growing in different seasons of the ar is difficult to check unless attention is directed to all the ps that offer food to it. The peculiarity of the pest in continu- to live actively through the winter without any sort of hiber- tion puts further difficulties in the way.

32. In districts where rice, jowár and wheat are all present e cheapest way to combat the pest seems to be to uproot the bbles of rice and jowári after they are harvested. This will prevent a large extent damage caused to early wheat which seems to fer to the greatest extent from this pest. The next step is to nove and burn all plants that die early in the season. In wheat ich is specially required to be saved from this pest, spraying with d arseniate will kill all the caterpillars that hatch out of the gs laid by the moths of the early brood.

EXPERIMENT TO INVESTIGATE THE BEST METHODS TO PRESERVE SEED OF VALUABLE CROPS FOR SOWING PURPOSES.

33. The substances that were tried were (i) camphor, (ii) naphthaline, (iii) neem leaves, (iv) wood ashes, and (v) fine river sand. The grain was first thoroughly dried in the sun in a layer not more than one inch thick and on a newly plastered threshing ground. When it was thoroughly dry it was put into clean earthen jars, capacity two maunds. The quantity of naphthaline and camphor used was three ounces and these were placed at the bottom of the jars and the grain then poured over them.

The other three substances were placed over the top of the grain which was first put into the jars. The experiment was meant only for the preservation of small quantities of grain sufficient for seed purposes.

The following statement gives the results :—

Date and month of Examination.	Camphor.	Naphthaline.	Neem leaves.	Wood ashes.	Fine river sand.
February 23rd .	Sound ...	Sound ...	Sound ...	Sound ...	Sound.
March 23rd ...	Do. ...	Do. ...	Do. ...	Do. ...	Do.
April 23rd ...	Do. ...	Do. ...	Do. ...	Do. ...	Do.
May 23rd ...	Slightly attacked.	Do. ...	Do. ...	Do. ...	Do.
June 23rd ...	Do. ...	Slightly attacked.	Slightly attacked.	Do. ...	Do.

In the case of those jars wherein the seed was attacked the damage done was only a trifling amount and happened very late in the experiment. It will be observed that wood ashes and fine river sand have preserved the grain intact throughout the whole period.

Collection.

4. The collection of 1906-07 has not been to any extent ed, but many more economic insects have been reared and fied. The collection has been satisfactorily arranged and d labels attached to them after proper numbering. A gene- llection has not been made in the year under report, but next ttempts will be made to increase the general collection which e kept with my Assistant Entomologist who will supervise eparation of small collections of all the more important ous insects which will be kept on each farm for the general tion of the staff and also for the information of interested rs.

5. The following is a list of the economic collection ified up to the present time and my thanks are due to efroy for the numerous insects which he has identified on f of the Bombay Agricultural Department :—

Acrididæ.

otogonus trachyptirus *Blanch*...		Young bájri, jowár or maize.
actomorpha crenulata *Fabr*	...	Do.
iroglyphus furcifer *Serv*	...	Rice, jowár, maize.
idium succintum *Linn*	...	Cosmopolitan.
idium peregrinum *Oliv*	...	Do.
yllotalpa africana *Pal*	...	Tobacco seedlings.

Locustidæ.

hisodactylus monstrosus *Drury*...		Tobacco.

Neuroptera.

mes obesus *Ramb*	...	Almost all crops and trees.

Tenthredinidæ.

halia proxima *Klug*	...	Cruciferous vegetables.

Scarabidæ.

ctis rhinocerus *Linn*	...	Palms.
loloba acuta *Wied*	...	Jowári.

Buprestidæ.

enoptera gossypii *Kerr*	...	Cotton.

Cantharidæ.

Cantharis tenuicollis *Pall*	...	Jowári and maize.
Cantharis rouxi *Cast*	...	Rice, jowári amd maize.
Mylabris pustulata *Thumb*	...	Cucurbitous plants.

Chrycomelidæ.

Aulacophora foveicollis *Kust*	...	Cucurbitous plants.
Hispa æneescens *Baly*	...	Rice.
Liptispa pygmea *Baly*	...	Rice.

Curculionidæ.

Myllocerus maculosus *Dist*	...	Cotton.
Tanymecus indicus	...	Jowár and maize.
Rhyncophorus signaticollis *Chevr*	...	Palms.

Nymphalidæ.

Melanitis ismene *Cram*	...	Rice and jowári.
Junonia almana	...	Rice.

Lycænidæ.

Virachola isocrates *Fabr*	...	Pomegranate.

Peridæ.

Peiris brassica *Linn*	...	Cabbage.

Hesperidæ.

Chapra mathias *Fabr*	...	Maize and rice.

Sphingidæ.

Acherontia styx *Westw*	...	Til.
Hirse convolvuli *Linn*	...	Udid.

Lasiœampidæ.

Trabala vishnu *Lef*	...	Castor

Arctiidæ.

Diacrisia obliqua *Wlk*	...	Cosmopolitan.
Amsacta lactinea *Cram*	...	Rice, jowár and weeds.
Utethesia pulchella *Linn*	...	Sann hemp.

Noctuidæ.

Chloridea obsoleta *Fabr*	...	Gram, peas.
Agrotes ypsillon *Roth*	...	Onions.
Prodenia littoralis *Boisd*	...	Grasses.
Caradrina exigua *Hubn*	...	Lucerne.
Nonagria uniformis *Ddgn*	...	Rice, jowári, maize.

Terache catena *Sow*	...	Cotton.
Earias fabia *Stoll*	...	Do.
Earias insulana *Boisd*	...	Do.
Ophiusa melicerta *Drury*	...	Castor.
Plusia signata *Fabr*	...	Cruciferous vegetables.
Plusia orichalca *Fabr*	...	Do.
Chilo simplex *Butl*	...	Sugarcane, maize and jowári.
Euzophora perticella *Rag*	...	Brinjal.
Etiella zinckenella *Treits*	...	Saidi beans.

Pyralidæ.

Zinckenia fascialis *Cram*	...	Grass.
Marasmia trapezalis *Green*	...	Bájri.
Silepta derogata *Fabr*	...	Cotton.
Antigastra catalaunalis *Dup*	...	Til.

Ptiropheridæ.

Excelasta parasita *Wols*	...	Tuar.

Timcidæ.

Gelechia gossypiella *Saund*	...	Cotton.
Gnorimoschema heliopa *Low*	...	Tobacco.
Plutella maculipennis *Curt*	...	Cabbage.

Tryfactidæ.

Dacus ferrugineous *Fabr*	...	Cucurbitous fruits.
Dacus cucurbitæ *Coq*	...	Do.
Carpomia pardalina *Big*	...	Boar.

Pentatomidæ.

Nezara viridula *Linn*	...	Jowár heads.
Bagrada picta *Fabr*	...	Cruciferous plants.

Lygcidæ.

Oxycarenus lætus *Kby*	...	Cotton, Bhindi.

Pyroceridæ.

Dysdercous cingulatus *Fabr*	...	Cotton.

Aphidæ.

Aphis brassica *Linn*	...	Cruciferous vegetables.
Aphis gossypii *Glov*	...	Cotton.
Aphis cardui *L.*	...	Gowár.
Siphenophora granaria *Kby*	...	Wheat.

White Ants.

36. With the object of determining the species of white ants that are destructive to cultivated crops a large number of insects were collected when found destroying different crops on the farms and a number of flying forms found at Nadiád were submitted for identification to the Imperial Entomologist. Three species of Termes were reported to be present in the lot submitted and one out of which was Termes obesus, the common field white ant. Attempts were made to rear flying forms of these ants under glass but they could not be reared to perfection. Later on when the new area was acquired for the Surat Farm all the ant hills about 50 in number were dug out as a precaution and a large number of queen ants were captured and reared. They lived for a month or at most for a month and a half and then died though all possible precautions were taken to keep them under as natural conditions as possible.

Work conducted in co-operation with the Imperial Department.

37. Since the appointment of Mr. Howlett, Second Imperial Entomologist to the Pusa Staff, that officer has turned his special attention to the order Diptera and local Agricultural Departments have accordingly been asked to supply Mr. Howlett with all the specimens of Trypetid Flies (fruit flies) which may be found in the provinces on the understanding that these insects will be returned to the Provincial Departments after identification and classification. In compliance with this arrangement the following statement gives a list of the Trypetid Flies forwarded to Pusa :—

List of Tripetidæ sent to Mr. Howlett, Second Entomologist.

Name.	Food plant.
I.—Dacus ferrugeneous ...	i Lufa acutangula. ii Momordica charantia. iii Cucumis sativus.
II.—Dacus cucurbita ...	i Lufa acutangula. ii Momordica charantia. iii Cucumis Sativus.
III.—Carpomiya pardalina ...	Zizipus jujuba, common Bordi of bazaar.

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